

Non-Aqueous Phase Liquids

The U.S. Department of Energy (DOE) is implementing two aggressive innovative technologies to address groundwater contaminated with non-aqueous phase liquids at the Northeast Site located at the northeast corner of the Young-Rainey Science, Technology, and Research (STAR) Center in Largo, Florida, formerly known as the Pinellas STAR Center. A non-aqueous phase liquid is a solvent or other liquid that has limited solubility in water. The cleanup is being conducted as part of the Pinellas Environmental Restoration Project that is managed by the DOE Grand Junction Office.

Background

The Young-Rainey Science, Technology, and Research (STAR) Center is a former U.S. Department of Energy (DOE) facility located in Largo, Florida. Parts of the site are contaminated with organic solvents and metals that were used during the manufacture of neutron generators and other devices. In keeping with DOE's desire to contribute to economic development in the Tampa Bay region, DOE sold the facility to the Pinellas County Industrial Council on March 17, 1995.

The facility, formerly known as the Pinellas STAR Center, houses more than 20 businesses that range from administrative to light manufacturing.

As a result of historic waste disposal practices, contamination exists in the subsurface. The contaminated areas are designated as solid waste management units. Four units have contamination in shallow groundwater at levels in excess of protective standards and have been recommended for or are undergoing remediation. Groundwater at the Northeast Site, one of four remaining active solid waste management units, is contaminated with non-aqueous phase liquids (NAPLs).

Non-Aqueous Phase Liquids (NAPLs)

NAPLs are typically found in areas where large volumes of solvents or other types of liquids that have a limited solubility in water were used, handled, stored, or disposed of. NAPL contamination occurs when these solvents or liquids are released into the subsurface. A typical scenario for this release is when the metal skin of a buried drum containing solvent rusts through and the contents of the drum leak into the subsurface. Alternatively, the liquid may be spilled from a container on the ground surface.

The released or spilled solvent travels through soil until it reaches groundwater. It then begins to dissolve into or mix with the groundwater. In many cases, the amount of solvent that will mix with the groundwater is limited. This limit is referred to as the solubility of the solvent. Once the solubility limit is reached, the solvent will no longer mix with the groundwater and will

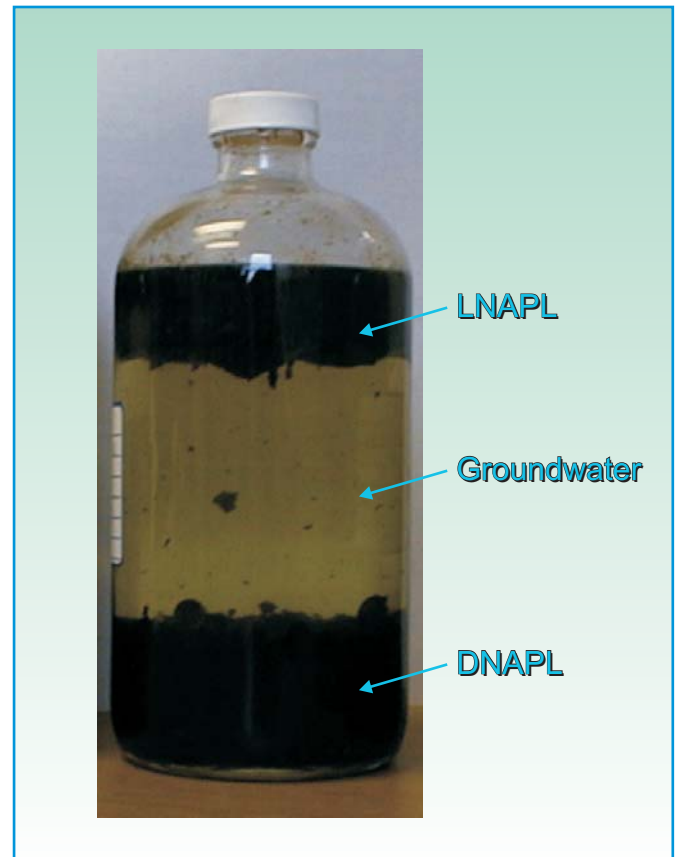


Figure 1. Groundwater sample collected at the Northeast Site

remain in the ground as a separate liquid, leading to the description of the solvent as a non-aqueous (not water) phase liquid.

NAPL solubility can be illustrated by visualizing pouring a liquid such as cooking oil or motor oil into a glass of water. The oil does not mix with the water but remains as a separate phase, a non-aqueous phase liquid. Figure 1 shows a groundwater sample collected at the Northeast Site that contains two kinds of NAPLs: a dense non-aqueous phase liquid (DNAPL) and a light non-aqueous phase liquid (LNAPL).

As contaminated groundwater moves away from the NAPL area, clean water will flow past the NAPL and more of the NAPL will mix with the clean water.

Though all the NAPL will eventually mix with groundwater, this process may take decades or even centuries because of the limited solubility of the NAPL.

The amount of time required for all the NAPL to mix with the groundwater depends on the chemical composition of the NAPL, the amount of NAPL in the subsurface, and the speed at which the groundwater flows past the NAPL-contaminated area. The NAPL acts as a continuous source of groundwater contamination until the mixing process is complete.

Efforts to clean the contaminated groundwater, such as pumping the water from the subsurface to the surface for treatment, may have little effect on reducing the contamination because the NAPL continues to mix with groundwater as the water is pumped. The NAPL must be removed before the groundwater can be cleaned up.

LNAPLs and DNAPLs

Two types of NAPL shown on Figure 1 (DNAPL and LNAPL) are distinguished from each other by the density of the chemicals that compose them. DNAPL has a density greater than the density of water and, therefore, typically will sink through groundwater. DNAPL will continue to sink until it encounters an obstacle such as a clay layer and may form a pool on top of the clay. LNAPL has a density less than that of water and thus will “float” on top of the groundwater.

NAPL Remediation

Remediation technologies used to clean up NAPLs include steam injection, electrical heating, chemical oxidation, bioremediation, surfactant injection, and soil removal. Steam injection uses boilers to generate steam, which is then injected into the NAPL area to convert the NAPL to a vapor. This NAPL vapor is then removed from the subsurface by extraction wells that

may pump both vapor and liquid from the subsurface. Electrical heating uses electrical current to heat the soil in the NAPL area to convert the NAPL to a vapor. This vapor is also pumped to the surface using extraction wells. Chemical oxidation uses an aggressive chemical that is injected into the NAPL area, where it attacks the NAPL and breaks it down into components that are not dangerous to the environment.

Researchers recently determined that some types of biological remediation may be effective at treating NAPLs. Chemicals may be injected into the NAPL area to aid microorganisms as they degrade the NAPLs. Surfactant injection increases the solubility of NAPLs, aiding in their removal from the subsurface. Soil removal consists simply of excavating all the soil that contains NAPLs, followed by either treatment of the soil on site or disposing of the soil at an approved disposal facility.

A combination of steam injection and electrical heating has been chosen to clean up the NAPL-contaminated area at the Young-Rainey STAR Center's Northeast Site.

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Additional information and fact sheets about the Pinellas Environmental Restoration Project at the Young-Rainey STAR Center are available on the Internet at <http://www.gjo.doe.gov/Pinellas/index.htm>.